passive mitigation systems are in place that serve to contain the spill and limit the surface area. Where passive mitigation is in place, the surface area of the contained liquid shall be used to calculate the volatilization rate.

(iii) If the release would occur onto a surface that is not paved or smooth, actual surface characteristics may be taken into account.

(iv) The volatilization rate shall account for the highest daily maximum temperature occurring in the past three years, the temperature of the substance in the vessel, and the concentration of the toxic propellants if the liquid spilled is a mixture or solution.

(v) The rate of release to the air shall be determined from the volatilization rate of the liquid pool. A launch operator shall use either the methodology provided in the Risk Management Plan (RMP) Offsite Consequence Analysis Guidance, available at http:/www.epa.gov/swercepp/ap-ocgu.htm, or an air dispersion modeling technique in accordance with paragraph (g) of this section.

(3) *Worst-case release scenario for toxic gases.* A launch operator's worst-case release scenario for a toxic gas shall be in accordance with the following:

(i) For toxic propellants that are normally gases at ambient temperature and handled as a gas or as a liquid under pressure, assume that the quantity in the vessel, or pipe, determined according to paragraph (e)(1) of this section, is released as a gas over 10 minutes. The release rate shall be assumed to be the total quantity divided by 10 unless passive mitigation systems are in place.

(ii) For gases handled as refrigerated liquids at ambient pressure, if the released toxic propellant is not contained by passive mitigation systems or if the contained pool would have a depth of 1 cm or less, assume that the toxic propellant is released as a gas in 10 minutes.

(iii) For gases handled as refrigerated liquids at ambient pressure, if the released toxic propellant is contained by passive mitigation systems in a pool with a depth greater than 1 cm, assume that the quantity in the vessel or pipe, determined in accordance with paragraph (e)(1) of this section, is spilled instantaneously to form a liquid pool. The volatilization rate shall be calculated at the boiling point of the toxic propellant and at the conditions specified in paragraph (e)(2) of this section.

(4) *Consideration of passive mitigation.* Passive mitigation systems may be accounted for in the analysis of worst case if the passive mitigation system is capable of withstanding the release event triggering the scenario and would function as intended.

(5) *Additional factors in selecting a worst-case scenario.* A launch operator's worst-case release scenario for a toxic propellant must account for any other factors that would result in a greater toxic hazard distance, such as a smaller quantity of the toxic propellant than required by paragraph (e)(1) of this section that is handled at a higher process temperature or pressure.

(f) *Worst-case credible alternative release scenario analysis.* A launch operator's worst-case credible alternative release scenario analysis must account for all of the following:

(1) The worst-case credible release scenario for each toxic propellant and for each toxic propellant handling process.

(2) Any release event that is more likely to occur than the worst-case release scenario that is determined according paragraph (e) of this section.

(3) Any release scenario that exceeds a toxic concentration threshold at a distance that reaches the general public.

(4) Any potential transfer hose releases due to splits or sudden hose uncoupling.

(5) Any potential process piping release from failures at flanges, joints, welds, valves and valve seals, and drains bleeds.

(6) Any potential process vessel or pump release due to cracks, seal failure, or drain, bleed, or plug failure.

(7) Vessel overfilling and spill, or over pressurization and venting through relief valves or rupture disks.

(8) Shipping container mishandling and breakage or puncturing leading to a spill.

(9) Mishandling or dropping hardware (flight or ground) that contains toxic commodities.

(10) Active and passive mitigation systems provided they are capable of withstanding the event that triggered the release and would still be functional.

(11) History of accidents experienced by the launch operator involving the release of a toxic propellant.

(12) Failure scenarios.

(g) *Toxic hazard distances for launch processing.* For each process involving a toxic propellant, a launch operator shall perform an air dispersion analysis to determine the hazard distance for the worst-case release scenario or the worst-case credible release scenario determined according to paragraphs (e) and (f) of this section. A launch operator shall use either the methodology provided in the RMP Offsite Consequence Analysis Guidance or an air dispersion modeling technique that is applicable to the proposed launch. Through the licensing process, a launch operator shall demonstrate, clearly and convincingly, the applicability of its air dispersion modeling technique to the proposed launch. A launch operator's air dispersion modeling technique must account for the following analysis parameters:

(1) *Toxic concentration thresholds.* When determining a toxic hazard distance for launch processing at a U.S. launch site, a launch operator shall use the toxic concentration thresholds determined in accordance with § I417.3(c).

(2) *Wind speed and atmospheric stability class.* For the worst-case release analysis, a launch operator shall use a wind speed of 1.5 meters per second and atmospheric stability class F. If it can be demonstrated that local meteorological data applicable to the source of a toxic release show a higher wind minimum wind speed or less stable atmosphere at all times during the three previous years, these minimums may be used. For analysis of the worst-case credible alternative scenario, the launch operator shall use statistical meteorological conditions for the location of the source.

(3) *Ambient temperature and humidity.* For a worst-case release scenario analysis of a toxic propellant, the highest daily maximum temperature from the last three years and average humidity for the site, based on temperature and humidity data gathered at the source location or at a local meteorological station shall be used. For analysis of worst-case credible alternative release scenarios typical temperature and humidity data gathered at the source location or at local meteorological station shall be used.

(4) *Height of release.* The worst-case release of a toxic propellant shall be analyzed assuming a ground level release. For a worst-case credible alternative scenario analysis of a toxic propellant, the release scenario may determine release height.

(5) *Surface roughness.* Either an urban or rural topography shall be used, as appropriate. Urban means that there are many obstacles in the immediate area; obstacles include buildings or trees. Rural means there are no buildings in the immediate area and the terrain is generally flat and unobstructed.

(6) *Dense or neutrally buoyant gases.* Models or tables used for dispersion analysis of a toxic propellant must account for gas density.

(7) *Temperature of release substance.* For worst-case, liquids other than gases liquefied by refrigeration only shall be considered to be released at the highest daily maximum temperature, based on data for the previous three years appropriate to the source of the potential toxic release, or at process temperature, whichever is higher. For worst-case credible alternative scenarios, toxic propellants may be considered to be released at a process or ambient temperature that is appropriate for the scenario.

(h) *Toxic hazard areas for launch processing.* Having determined the toxic hazard distance for the toxic concentration threshold for each toxic propellant involved in a process using either a worst-case release scenario or a worst-case credible alternative release scenario, a launch operator shall determine the toxic hazard area for the process as a circle centered at the potential release point with a radius equal to the greatest toxic hazard distance for all the toxic propellants involved in the process. A launch vehicle processing operation is exempt from any further requirements in this section if:

(1) The launch operator ensures there are no populated areas contained or partially contained within the toxic hazard area; and

(2) The launch operator ensures that no member of the public is present within the toxic hazard area during the process.

(i) *Evacuation of populated areas within a toxic hazard area.* For a process where there is a populated area that is contained or partially contained within the toxic hazard area, the launch processing operation is exempt from any further requirements in this section if the launch operator evacuates all members of the public from the populated area and ensures that no member of the public is present within the toxic hazard area during the operation. A launch operator shall coordinate notification and evacuation procedures with the Local Emergency Planning Committee (LEPC) and ensure that notification and evacuation is implemented

according to its launch plans submitted during the licensing process, according to § 415.119, including the launch operator's ground safety plan, security and hazard area surveillance plan and public coordination plan.

(j) *Meteorological constraints for launch processing.* For a launch processing operation with the potential for a toxic release where there is a populated area that is contained or partially contained within the toxic hazard area and that will not be evacuated according to paragraph (i) of this section, the operation is exempt from any further requirements in this section if the launch operator constrains the process to favorable wind conditions or during times when atmospheric conditions result in reduced toxic hazard distances such that any potentially affected populated area is outside the toxic hazard area. A launch operator shall employ wind and other meteorological constraints in accordance with the following:

(1) A launch operator shall limit a launch processing operation to times during which prevailing winds will transport any toxic release away from populated areas that would otherwise be at risk. To accomplish this, the launch operator shall re-define the toxic hazard area by reducing the circular toxic hazard area determined according to paragraph (h) of this section to one or more arc segments that do not contain any populated area. Each arc segment toxic hazard area must have the same radius as the circular toxic hazard area and must be defined by a range of downwind bearings. When applying this approach, the mean wind speed during the operation must be equal to or greater than four knots. If the mean wind speed is less than four knots, the toxic hazard area for the operation must be the full 360-degree toxic hazard area determined in accordance with paragraph (h) of this section. The total arc width of an arc segment hazard area for launch processing must be greater than or equal to 30 degrees. If the launch operator determines the standard deviation of the measured wind direction, ± three-sigma shall be used for the arc segment hazard area; otherwise, the following apply for the conditions defined by the Pasquil-Gifford meteorological stability classes:

(i) For stable classes (D–F), if the mean wind speed is less than 10 knots, the total arc width of the arc segment toxic hazard area must be no less than 90 degrees.

(ii) For stable classes (D–F), if the mean wind speed is greater than or equal to 10 knots, the total arc width of the arc segment toxic hazard area must be no less than 45 degrees.

(iii) For neutral class (C), the total arc width of the arc segment toxic hazard area must be no less than 60 degrees.

(iv) For slightly unstable class (B), the total arc width of the arc segment toxic hazard area must be no less than 105 degrees.

(v) For mostly unstable class (A), the total arc width of the arc segment toxic hazard area must be no less than 150 degrees.

(2) The launch operator shall ensure that there are no populated areas within any arc segment toxic hazard area and that no member of the public is present within an arc segment toxic hazard area during the process in accordance with paragraph (i) of this section.

(3) A launch operator shall establish wind constraints to ensure that any winds present at the time of an operation will transport any toxicant into an arc segment toxic hazard area and away from any populated area. For each arc segment toxic hazard area, the wind constraints must consist of a range of downwind bearings that are within the arc segment toxic hazard area and that provide a safety buffer, in both the clockwise and counterclockwise directions, that accounts for any uncertainty in the spatial and temporal variations of the transport winds.

(4) A launch operator may reduce the radius of the circular toxic hazard area determined according to paragraph (h) of this section by imposing operational meteorological restrictions on specific parameters that mitigate potential toxic downwind concentrations levels at any potentially affected populated area to levels below the toxic concentration threshold of the toxicant in question. The launch operator shall establish meteorological constraints to ensure that the operation will be allowed to occur only if the specific meteorological conditions that would reduce the toxic hazard area exist and will continue to exist throughout the operation, or the operation will be terminated.

(k) *Implementation of meteorological constraints.* A launch operator shall use one or more of the following approaches to determine wind direction or other meteorological conditions in order to implement constraints on a launch processing operation or implement evacuation of a populated area in a potential toxic hazard area:

(1) The launch operator shall ensure that the wind conditions at the time of the process are in accordance with the wind constraints used to define each arc segment toxic hazard area. The launch operator shall monitor the vertical profile of winds at the potential toxic release site from ground level to an altitude of 10 meters or the maximum height above ground of the potential release, which ever is larger. The launch operator shall proceed with a launch processing operation only if all wind vectors meet the wind constraints used to define each arc segment toxic hazard area.

(2) A launch operator shall monitor the specific meteorological parameters that affect toxic downwind concentrations at a potential toxic release site for a process and for the sphere of influence out to each populated area within the potential toxic hazard area determined in accordance with paragraph (h) of this section. The launch operator shall monitor any spatial variations in the wind field that could affect the transport of toxic material between the potential release site and any populated areas. The launch operator shall acquire real-time meteorological data from sites between the potential release site and each populated area sufficient to demonstrate that the toxic hazard area, when adjusted to the spatial wind field variations, excludes any populated area. All meteorological parameters that affect toxic downwind concentrations from the potential release site and covering the sphere of influence out to the populated areas must fall within the conditions determined according to paragraph (j)(4) of this section. A launch operator shall use one of the following methods to determine the meteorological conditions that will constrain a launch processing operation:

(i) A launch operator may employ real-time air dispersion models to determine the toxic hazard distance for the toxic concentration threshold of a toxicant and its proximity to any populated area. When employing this method, a launch operator shall proceed with a launch processing operation only if real-time modeling of the potential release demonstrates that the toxic hazard distance would not reach any populated area. The launch operator's process for implementing this method must include the use of an air dispersion modeling technique that satisfies paragraph (g) of this section and providing real-time meteorological data for the sphere of influence around a potential toxic release site as input to the air dispersion model. The launch operator's process must also include a review of the meteorological conditions to identify any changing conditions that could affect the toxic hazard distance for a toxic concentration threshold prior to proceeding with the operation.

(ii) A launch operator may use air dispersion modeling techniques to define the meteorological conditions that, when they exist, would preclude a toxic hazard distance for a toxic concentration threshold from reaching any populated area. When employing this method, the launch operator shall constrain the associated launch processing operation to be conducted only when the prescribed meteorological conditions exist. A launch operator's air dispersion modeling technique must be in accordance with paragraph (g) of this section.

(l) *Statistical toxic risk management for launch processing.* If a process that involves the use of a toxic propellant does not satisfy the containment requirements of paragraph (d) of this section, the launch operator shall use statistical toxic risk management to protect public safety. For each such case, a launch operator shall perform a toxic risk assessment and develop criteria that protect the public from unacceptable risk due to planned and potential toxic release. A launch operator shall ensure that the resultant toxic risk meets the collective and individual risk criteria requirements contained in § 417.107(b). A launch operator's toxic risk assessment must account for the following:

(1) All credible equipment failure and non-failure modes, along with the consequent release and combustion of toxic propellants.

(2) Equipment failure rates.

(3) The effect of positive or negative buoyancy on the rise or descent of the released toxic propellants.

(4) The influence of atmospheric physics on the transport and diffusion of toxic propellants released.

(5) Meteorological conditions at the time of the process.

(6) Population density, location, susceptibility (health categories) and sheltering for all populations within each potential toxic hazard area.

(7) Exposure duration and toxic propellant concentration or dosage that would result in casualty for all populations.

(m) *Launch processing toxic release hazard analysis products.* The products of a launch operator's toxic release hazards analysis for launch processing that must be included as part of the launch operator ground safety analysis report in accordance with § 415.117(a) and appendix C of part 415 of this chapter must include the following:

(1) For each worst-case release scenario, a description of the vessel or pipeline and toxic propellant selected as the worst case for each process, assumptions and parameters used, and the rationale for selection; assumptions must include use of any administrative controls and any passive mitigation that were assumed to limit the quantity that could be released. The description must include the anticipated effect of any controls and mitigation on the release quantity and rate.

(2) For each worst-case credible alternative release scenario, a description of the scenario identified for each process, assumptions and parameters used, and the rationale for the selection of that scenario. Assumptions must include use of any administrative controls and any passive mitigation that were assumed to limit the quantity that could be released. The description must include the anticipated effect of the controls and mitigation on the release quantity and rate.

(3) Estimated quantity released, release rate, and duration of release for each worst-case scenario and worst-case credible alternative scenario for each process.

(4) A description of the methodology used to determine the toxic hazard distance for each toxic concentration threshold.

(5) Data used to estimate off-site population receptors potentially affected.

(6) The following data for each worst-case scenario and worst-case credible alternative release scenario:

(i) Chemical name.

(ii) Physical state.

(iii) Basis of results (provide model name if used, or other methodology).

(iv) Scenario (explosion, fire, toxic gas release, or liquid spill and vaporization).

(v) Quantity released in pounds.

(vi) Release rate.

(vii) Release duration.

(viii) Wind speed and atmospheric stability class.

(ix) Topography.

(x) Toxic hazard distance.

(xi) Any member of the public within the toxic hazard distance.

(xii) Any passive mitigation considered.

(xiii) Active mitigation considered (worst-case credible alternative release scenario only).

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